ORIGINAL RESEARCH

Community-Wide Dissemination of Bystander Cardiopulmonary Resuscitation and Automated External Defibrillator Use Using a 45-Minute Chest Compression–Only Cardiopulmonary Resuscitation Training

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***Background*—**Little is known about whether cardiopulmonary resuscitation (CPR) training can increase bystander CPR in the community or the appropriate target number of CPR trainings. Herein, we aimed to demonstrate community-wide aggressive dissemination of CPR training and evaluate temporal trends in bystander CPR.

***Methods and Results*—**We provided CPR training (45-minute chest compression–only CPR plus automated external defibrillator use training or the conventional CPR training), targeting 16% of residents. All emergency medical service–treated out-of-hospital cardiac arrests of medical origin were included. Data on patients experiencing out-of-hospital cardiac arrest and bystander CPR quality were prospectively collected from September 2010 to December 2015. The primary outcome was the proportion of high-quality bystander CPR. During the study period, 57 173 residents (14.7%) completed the chest compression–only CPR training and 32 423 (8.3%) completed conventional CPR training. The proportion of bystander CPR performed did not change (from 43.3% in 2010 to 42.0% in 2015; *P* for trend=0.915), but the proportion of high-quality bystander CPR delivery increased from 11.7% in 2010 to 20.7% in 2015 (*P* for trend=0.015). The 1-year increment was associated with high-quality bystander CPR (adjusted odds ratio, 1.461; 95% CI, 1.055–2.024). Bystanders who previously experienced CPR training were 3.432 times (95% CI, 1.170–10.071) more likely to perform high-quality CPR than those who did not.

***Conclusions*—**We trained 23.0% of the residents in the medium-sized city of Osaka, Japan, and demonstrated that the proportion of high-quality CPR performed on the scene increased gradually, whereas that of bystander CPR delivered overall remained stable.
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Key Words: bystander cardiopulmonary resuscitation • cardiac arrest • cardiopulmonary resuscitation • chest compression • education

Sudden cardiac death is one of the leading causes of death in many regions worldwide.[1–4] Cardiopulmonary resuscitation (CPR) and the use of public-access automated external defibrillators (AEDs) by bystanders play a key role in increasing survival rates after out-of-hospital cardiac arrests (OHCAs).[1–6] However, despite the proven effectiveness of CPR and AEDs, their use by bystanders remains low in most areas of the world, including Japan.[1–4,7]

To increase bystander CPR and AED use, many practical training and enlightening advertisements have been enthusiastically performed for the general public.[8–10] In Japan, municipal fire departments are the largest parties to train CPR

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Clinical Perspective

What Is New?

- We a priori set a cardiopulmonary resuscitation (CPR) training program targeting 16% of residents in the community and provided a simplified mass chest compression–only CPR training or a conventional CPR training for 89 596 residents (23.0% of all residents) during 5 years.
- In this initiative, high-quality bystander CPR performed at the scene increased and its implementation was associated with previous experience in CPR training, whereas the proportion of patients who received bystander-initiated CPR and the survival from out-of-hospital cardiac arrest did not change during the study period.

What Are the Clinical Implications?

- To spread the CPR training in communities with limited time and resources, the simplified mass chest compression–only CPR training course would be useful.
- Multiple interventions, including mass CPR training, media campaign, advertisement materials, and social media technologies, are also warranted to further disseminate the CPR implementation and subsequently increase the out-of-hospital cardiac arrest survival in communities.

to lay rescuers and they have been providing CPR training programs to nearly 2 million people every year, mainly with a 3-hour program.[8] However, such programs may have many burdens, such as time and cost for attendees, instructors, and parties providing the CPR training course.[11–13]

In the past decade, many experimental and clinical studies have suggested that chest compression–only CPR (CCCPR) is as effective as chest compression plus rescue breathing (conventional CPR) for most cardiac arrest cases[14–16] and even more effective for some types of cardiac arrests.[17–19] CCCPR is attractive because it is not only clinically effective but also easier to teach, learn, and perform than conventional CPR.[20] Herein, we developed a simplified 45-minute training program of CCCPR and AED use with a personal training kit named Mr. PUSH and demonstrated its effectiveness in a randomized simulation study.[21] The Japanese resuscitation guidelines recommend that communities train CCCPR and AED use to citizens in a shorter training course in addition to conventional 3-hour CPR training to further disseminate CPR.[4] Recently, some studies have investigated an effectiveness of multiple interventions, including CPR training, mass training events, a media campaign, and advertisement materials, in communities.[22–24] However, there were no exact data on interventions, such as the number of CPR training sessions, the number of CPR training trainees, characteristics of trainees, or the quality of CPR by bystanders. Herein, little is known about whether wider dissemination of CPR training can increase bystander CPR in the community or whether bystanders who attended a CPR training can perform CPR appropriately on the scene.

The objective of this study is to demonstrate the effectiveness of the community-wide aggressive dissemination of CPR training using the 45-minute training program of CCCPR and AED use, targeting 16% of the population, the inflection point for breakthrough.[25]

Methods

The data, analytic methods, and study materials will not be made available to other researchers for purposes of reproducing the results or replicating the procedure.

Study Design and Period

We aggressively provided CPR training targeting 16% of residents in our study area and evaluated the temporal trends of the proportions of bystander CPR and the quality of CPR using a population-based registry of OHCAs from September 2010 through December 2015.

Study Setting and Population

Toyonaka City in Osaka Prefecture, Japan, has 403 260 residents; 100 006 of them (24.8%) were at aged ≥65 years in 2015. During the study period (2010–2015), the number of residents increased by 13 799, with a final population of 403 260. The study population was composed of the residents aged ≥11 years. The study has an area of 36.39 km^2 and includes both urban and semirural communities along with 9 fire departments and 1 dispatch center.

Emergency Medical Service System in Osaka

Emergency services are provided 24 hours a day, and anyone can freely call for an ambulance by telephoning emergency number 119. Telephone-assisted CPR instruction by dispatchers was conducted for untrained bystanders, and conventional CPR instruction was conducted for trained lay rescuers who were able to perform rescue breathing under the 2005 CPR guidelines since 2006.[26] Moreover, dispatchers started to encourage bystanders to provide CCCPR if it was difficult for them to administer rescue breathing. We previously described the details of the Japanese emergency medical service (EMS) system.[5,6] Highly trained emergency care providers are called emergency life-saving technicians, and each ambulance has a crew of 3 emergency providers, including at least 1 emergency life-saving technician. AED use by citizens was

legally approved in July 2004. All of Japan's EMS personnel deliver CPR according to Japanese CPR guidelines.

More important, prehospital do-not-resuscitate orders or living wills are not generally accepted in Japan. Furthermore, EMS personnel are not allowed to terminate resuscitation in prehospital settings. All patients experiencing OHCA and treated by EMS personnel are, therefore, transported to a medical institution and basically registered in our registry described below, except for those affected by rigor mortis, decapitation, dependent cyanosis, incineration, or decomposition.

Study Population

The study included all cases of OHCA of medical origin in which chest compressions were performed by EMS personnel. The cause of cardiac arrest was presumed to be medical origin, unless it was caused by trauma, drug overdose, drowning, electrocution, or asphyxia.[27] However, patients with EMS-witnessed arrest, known pregnancy, uncontrolled bleeding, and life-threatening traumatic injuries, drowning, or asphyxia were excluded.

CPR Training for the Community

The Toyonaka City Fire Department has provided a conventional 3-hour CPR training consisting of chest compressions, rescue breathing, and AED use (ie, conventional CPR course) and an instructor training course to the local residents at companies, governmental offices, and nursing homes. In addition, the fire department introduced a 45-minute CCCPR plus AED use (PUSH course) training and provided either conventional CPR or CCCPR course in response to trainee requests. Especially for schools, the Toyonaka City Fire Department introduced systematic CPR training programs with CCCPR-collaborating municipal board of education. The fire department recorded data on date of CPR training, type of CPR training, number of participants, participants' age, sex, occupation, such as teachers, workers, and students, and so on.

Details of the PUSH course were previously described.[21] Briefly, the PUSH course, developed by the Osaka Life Support Association (http://osakalifesupport.jp/push_e/index.html), was a video-based CPR training program and consisted of the instruction and practice for the following: (1) the recognition of cardiac arrest and emergency calls, (2) chest compressions, and (3) AED use. The participants used a Mr. PUSH CPR training kit to practice chest compressions and AED use. This compact personal training kit gives a sound when a trainee attains a chest compression with appropriate power to reach the ideal 5-cm depth.

Before the study, ≈2% of residents per year (7733 [2.0%] in 2005, 7329 [1.9%] in 2006, 9234 [2.4%] in 2007, 8553 [2.2%] in 2008, and 5752 [1.5%] in 2009) participated in the conventional CPR course provided by the Toyonaka City Fire Department. The proportion of CCCPR and bystander CPR (either CCCPR or conventional CPR) increased from 17.3% in 2005 to 26.2% in 2009 and from 31.7% in 2005 to 40.3% in 2009, respectively, before CCCPR training implementation. The 1-month survival and 1-month survival with favorable neurological outcome were 15 of 139 (10.8%) and 4 of 139 (2.9%) in 2005, 12 of 147 (8.2%) and 5 of 147 (3.4%) in 2006, 16 of 162 (9.9%) and 6 of 162 (3.7%) in 2007, 18 of 158 (11.4%) and 12 of 158 (7.6%) in 2008, and 21 of 149 (14.1%) and 15 of 149 (10.1%) in 2009, respectively. According to Rogers' diffusion of innovations model, there is a penetration point at ≈16% (2.5% innovators+13.5% early adaptors) in the adoption process of new ideas or technologies.[25] We, therefore, set the target population of CPR training at 16% of the population of Toyonaka City to break the barrier of providing CPR and using an AED. To train ≥16% of the population within a few years, we introduced the PUSH course in addition to the conventional training course. We tried to provide CPR training for 4% to 5% of residents every year since April 2010.

Data Collection, Definitions, and Quality Control

Data on patients experiencing OHCA were prospectively collected using a specified form that included all core data recommended in the Utstein-style reporting guidelines for cardiac arrest, such as sex, age, arrest location, activities of daily living before the arrest, first documented cardiac rhythm, resuscitation time course, bystander-initiated CPR type, and public-access AED use as well as prehospital return of spontaneous circulation, hospital admission, 1-month survival, and neurological status 1 month after the event. In addition, data on the characteristics of the bystanders and their CPR were collected by EMS personnel in the prehospital emergency settings. Herein, the bystander was defined as a person who performed chest compressions with or without mouth-to-mouth ventilation for the patient experiencing OHCA. If there were ≥2 rescuers, the person who performed chest compressions at EMS arrival was evaluated as a bystander. Bystander characteristics included age, sex, occupation, and previous CPR training. Quality of CPR was judged according to the following criteria: (1) hand positions: correct was defined as between the nipples, whereas incorrect was without the correct position, and unassessable; (2) compression depth: correct was ≥4 cm, whereas incorrect was without the above definition, and unassessable; and (3) compression rates: correct was 100 to 120 per minute, whereas too fast was ≥120 per minute and too slow was <100 per minute, and unassessable.

The data form was filled out by the EMS personnel caring for the patient, transferred to Kyoto University as deidentified

data, and checked by the researchers. If the data sheet was incomplete, the relevant EMS personnel were contacted and questioned and the data sheet was completed as much as possible.

We prepared a self-learning video consisting of 11 patterns of bystander CPR to assess CPR quality, and the EMS personnel were required to watch this video to standardize their evaluation skills before the beginning of the study. After the video-based self-learning, all the EMS personnel were tested for their bystander CPR assessment proficiency. In this test, each participant watched 24 cases of bystander CPR one by one and then evaluated the bystander's hand position (correct, incorrect, or unassessable), chest compression tempo (correct, too fast, too slow, or unassessable), and chest compression depth (correct, incorrect, or unassessable) using a multiple-choice test. For the new EMS personnel, we also required the same training and test before starting data collections. To maintain the quality of data in evaluating bystander CPR quality, we required a κ statistic of 0.8 for the EMS personnel. At starting point, the κ statistic was 0.6, so we required retraining to attain the sufficient interobserver agreement; and after the κ statistic reached 0.8, we started to correct CPR quality data.[28] In addition, we conducted a follow-up test in August 2014 to confirm sufficient interobserver agreement, with a κ statistic of 0.8.

Outcomes

The primary outcome was the proportion of high-quality bystander CPR defined as the correct hand position, compression depth, and chest compression tempo. The secondary outcomes were the proportion of bystander CPR performed, 1-month survival, and 1-month survival with favorable neurological outcome.

Statistical Analysis

The trend in proportions of bystander CPR attempt and high-quality CPR was tested with a linear regression model. Data on bystander CPR quality were not available from September 2013 through August 2014. For the patients experiencing OHCA who received bystander CPR, stepwise multiple logistic regression analysis was performed to assess the factors associated with high-quality bystander CPR; odds ratios (ORs) and their 95% CIs were calculated. In addition, the trend in proportions of 1-month survival and 1-month survival with favorable neurological outcome was tested with a linear regression model adjusting sex and age of the patient. Adjusted ORs (AORs) and their 95% CIs were calculated. All statistical procedures were performed using SPSS, version 22.0J (IBM Corp, Armonk, NY). All tests were 2 tailed, and $P<0.05$ was considered statistically significant. The authors had full access to and take responsibility for the integrity of the data. All authors have read and agreed to the article as written.

Ethical Considerations

All procedures were conducted according to the Declaration of Helsinki. No identifiable data were treated in the study. This study was approved by the Ethics Committees of Kyoto University Graduate School of Medicine (registration No. E-658) and was registered at University Hospital Medical Information Network (UMIN000002061).

Results

During the study period, 57 173 residents of Toyonaka City (14.7% of the population) completed the 45-minute CCCPR training and 32 423 (8.3% of the population) completed the conventional CPR training. A total of 89 596 residents (23.0% of the population) completed either CPR training (Figure 1). The participants in CPR training provided by EMS personnel were classified as shown in Figure 2. The most frequent participants of CPR training were elementary school students (26.6%), followed by junior high school students (23.2%) and school teachers/parents (17.1%).

A total of 1394 patients who experienced OHCA were confirmed during the study period (Figure 3). Among them, we excluded 104 patients whose collapses were witnessed by EMS personnel, 98 who were not treated by EMS personnel, 283 who had nonmedical cardiac arrests, and 187 whose collapses occurred at a nursing home. Finally, 722 patients (411 with no bystander CPR, 311 with bystander CPR) were eligible for the analysis.

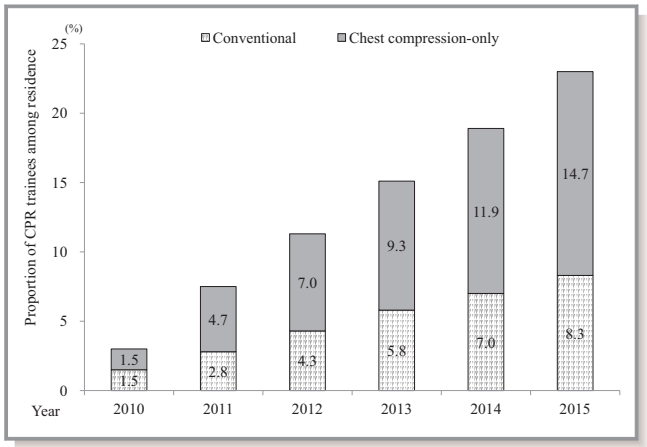

Figure 1. Cumulative proportion of cardiopulmonary resuscitation (CPR) trainees in Toyonaka City, Japan, from April 2010 through December 2015.

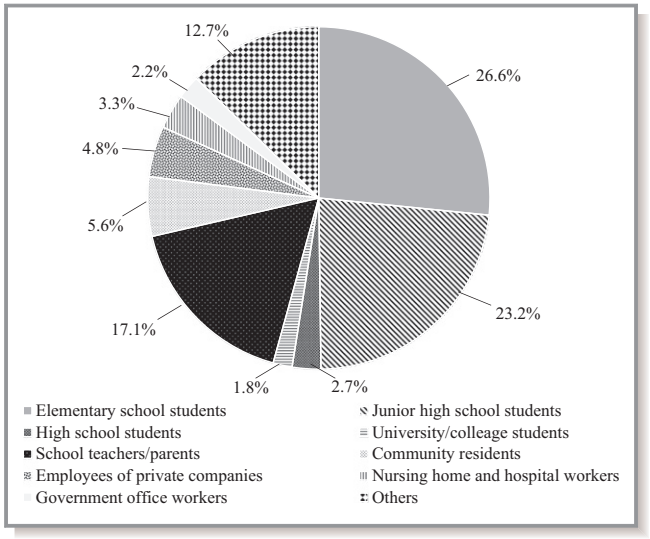

Figure 2. Classification of participants of cardiopulmonary resuscitation (CPR) training.

Table 1 shows the characteristics of the patients with medical OHCA who were treated and transported to the hospital by the EMS personnel. The mean age was 74.7 years; 61.5% of the patients were men. Among them, 594 (82.3%) succumbed at home, followed by 83 (11.5%) at a public place. Ventricular fibrillation was documented as the first rhythm in 9.1%, and shock was provided by public-access AED use in 0.8%. One-month survival with a favorable neurological outcome occurred in 3.9% of the patients.

During the study period, the trend in the proportion of bystander CPR did not change from 43.3% (26/60) in 2010 to 42.0% (78/188) in 2015 (*P* for trend=0.915) (Figure 4A), but the trend in the proportion of high-quality CPR increased from

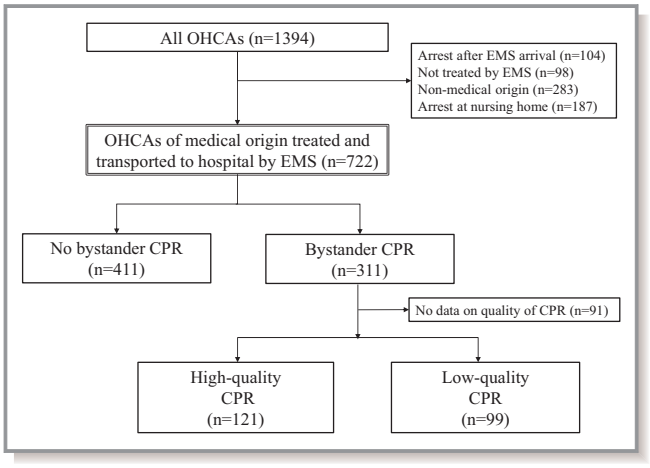

Figure 3. Targeted patients for quality of bystander cardiopulmonary resuscitation (CPR) from September 1, 2010, through August 31, 2013, and from September 1, 2014, through December 31, 2015. EMS indicates emergency medical service; OHCA, out-of-hospital cardiac arrest.

Table 1. Characteristics of Patients With Medical OHCA Treated and Transported to the Hospital by EMS Personnel

Characteristics	Value (n=722)
Male sex	444 (61.5)
Age, mean (SD), y	74.7 (15.9)
ADL, good	451 (62.5)
Cause, cardiac	635 (88.0)
Witness	
Witnessed by family members	259 (35.9)
Witnessed by others	71 (9.8)
Witnessed (unknown)	29 (4.0)
Nonwitnessed	363 (50.3)
Location	
Home	594 (82.3)
Public place	83 (11.5)
Others	21 (2.9)
Missing	24 (3.3)
Shock by public-access AEDs	6 (0.8)
Time from call to CPR by EMS personnel, median (IQR), mins*	7.0 (5.0–8.0)
First documented rhythm, VF	66 (9.1)
Prehospital ROSC	121 (16.8)
1-mo Survival	54 (7.5)
1-mo Survival with favorable neurological outcome	28 (3.9)

Data are number and proportion unless indicated otherwise. ADL indicates activities of daily living; AED, automated external defibrillator; CPR, cardiopulmonary resuscitation; EMS, emergency medical service; IQR, interquartile range; OHCA, out-of-hospital cardiac arrest; ROSC, return of spontaneous circulation; VF, ventricular fibrillation.
*Data of 5 patients were missing.

11.7% (7/60) in 2010 to 20.7% (39/188) in 2015 (*P* for trend=0.015) (Figure 4B).

The bystanders' characteristics are shown in Table 2. Healthcare providers accounted for 18.3%, and the proportion of bystanders who had completed previous CPR training was 20.6%. Table 3 shows the factors associated with high-quality bystander CPR. On the basis of the results of univariate analysis, year, bystander age, and previous CPR training were included in the multivariate analysis. A 1-year increment was associated with high-quality bystander CPR (AOR, 1.461; 95% CI, 1.055–2.024). Bystander age (1-year increment) was associated with a decreased proportion of high-quality bystander CPR (AOR, 0.961; 95% CI, 0.931–0.992). Bystanders who had experienced previous CPR training were 3.432 times (95% CI, 1.170–10.071 times) more likely to perform high-quality CPR compared with those without such an experience.

Table 4 shows the temporal trend in 1-month survival and 1-month survival with favorable neurological outcome. There

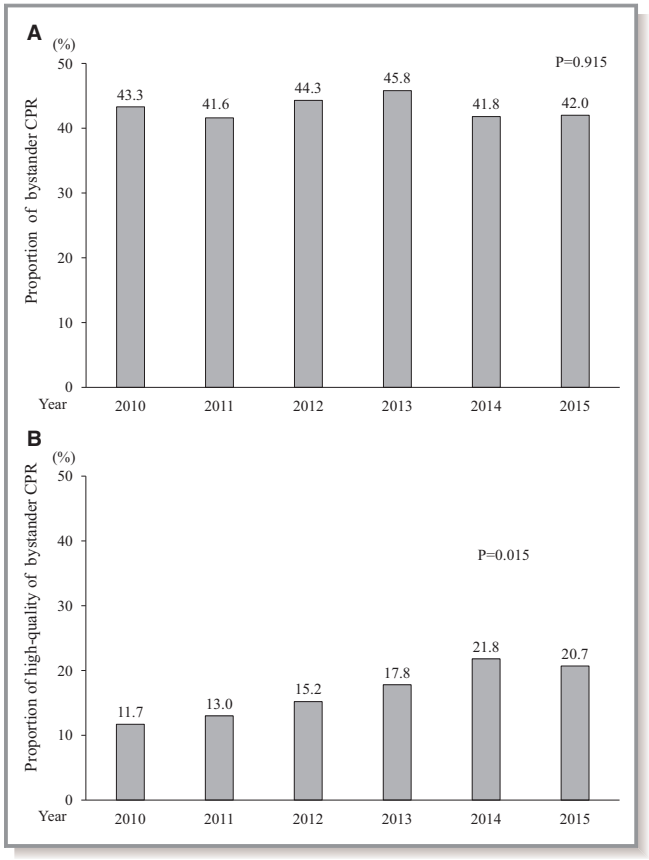

Figure 4. **A**, Temporal trend in proportion of bystander cardiopulmonary resuscitation (CPR). **B**, Temporal trend in proportion of high-quality bystander CPR. **A** and **B**, The periods from September 1, 2010, through August 31, 2013, and from September 1, 2014, through December 31, 2015.

were not statistically significant improvements in both proportion of 1-month survival (AOR, 0.949; 95% CI, 0.802–1.124) and 1-month survival with favorable neurological outcome (AOR, 0.947; 95% CI, 0.751–1.194) among those who were patients with medical OHCA.

Discussion

In this community-wide trial, we a priori set a target CPR training population of 16% of residents to breakthrough bystander CPR and AED use to further increase the proportion and quality of bystander CPR performance. We trained more than one fifth of the local population and demonstrated that high-quality CPR performed on the scene increased. In addition, high-quality bystander CPR performance was associated with experienced CPR training. However, the proportion of patients who received bystander-initiated CPR and survival did not change over the study periods. The continuous evidence-based challenges to increase bystander CPR and AED use were attained by recommending CCCPR,[4] the population-based OHCA registry, and the full collaborations

Table 2. Characteristics of Bystanders

Characteristics	Value (n=311)
Sex	
Male	97 (31.2)
Female	107 (34.4)
Unknown/missing	107 (34.4)
Age, mean (SD), y*	51.1 (16.0)
Occupation	
No healthcare provider	167 (53.7)
Healthcare provider	57 (18.3)
Unknown/missing	87 (28.0)
Previous CPR training	
Yes	64 (20.6)
No	50 (16.1)
Unknown/missing	197 (63.3)

Data are number and proportion unless indicated otherwise. CPR indicates cardiopulmonary resuscitation.
*Data are available for those with interview (n=285).

of the fire departments, nonprofit organizations, and researchers.

We successfully trained as many as 23% of the local population during the 5-year study period by using a simplified CCCPR and AED use training program, a figure that is ≈3 times higher than those of other standard areas in Japan.[8] Although some previous reports suggested the importance of CPR training experience to increase bystander CPR,[29,30] the lengthiness of conventional CPR training of 3 to 4 hours can be a barrier to its further dissemination.[13] As already shown in some experiences, CCCPR is feasible and effective for dissemination in communities.[7,10,31] To spread CPR education in communities with limited time and resources, this 45-minute shortened CCCPR plus AED course would make it possible to introduce a mass CPR training into communities, including schools. Strategic and systematic approaches using CCCPR are warranted to further disseminate CPR into communities, as shown in this study.

Unfortunately, despite training many people in this area as we planned, we could not demonstrate an increase in the proportion of bystander CPR and survival. There would be some possible explanations for this negative result. First, although approximately half of the trainees were schoolchildren, most OHCAs occur to the elderly generation, which was consistent with our previous study.[32] As many resuscitation guidelines or policies recommend, CPR education at school is a key to spreading CPR in communities,[33–35] but the young generation might have less opportunities to encounter collapses in daily life. Although schoolchildren would be potential bystanders, it may take more time to have a positive

Table 3. Association of Bystander and Prehospital Patient Factors With High Quality of CPR (N=220)

Variable	High Quality of CPR n/N (%)	Univariable Analysis OR (95% CI)	*P* Value	Multivariable Analysis OR (95% CI)	*P* Value
Year (1-y increment)		1.245 (1.055–1.470)	0.009	1.461 (1.055–2.024)	0.022
Patients' sex					
Male	65/126 (51.6)	Reference		. . .	. . .
Female	56/94 (59.6)	1.383 (0.806–2.374)	0.239	. . .	. . .
Patient's age (1-y increment)	. . .	0.986 (0.970–1.003)	0.097	. . .	. . .
Good activities of daily living before arrest					
Disability	46/88 (52.3)	Reference		. . .	. . .
Good	74/131 (56.5)	1.19 (0.689–2.039)	0.539	. . .	. . .
Cause					
Noncardiac	13/30 (43.3)	Reference		. . .	. . .
Cardiac	107/190 (56.3)	1.473 (0.781–3.190)	0.325	. . .	. . .
Witnessed					
No	58/109 (53.2)	Reference		. . .	. . .
Yes	63/111 (56.8)	1.154 (0.678–1.964)	0.597	. . .	. . .
Type of bystander CPR					
Conventional CPR with rescue breathing training	99/186 (53.2)	Reference		. . .	. . .
Chest compression–only CPR training	22/34 (64.7)	1.678 (0.766–3.676)	0.196	. . .	. . .
Location*					
Home	94/181 (51.9)	Reference		. . .	. . .
Public place	20/28 (71.4)	2.314 (0.969–5.524)	0.059	. . .	. . .
Other	3/5 (60.0)	1.388 (0.227–8.507)	0.723	. . .	. . .
Time from call to CPR by EMS personnel, median (IQR), mins†		1.003 (0.893–1.126)	0.963	. . .	. . .
Bystanders' sex‡					
Male	36/67 (53.7)	Reference		. . .	. . .
Female	35/78 (44.9)	0.701 (0.364–1.350)	0.288	. . .	. . .
Bystanders' age (1-y increment)§	. . .	0.960 (0.942–0.979)	<0.001	0.961 (0.931–0.992)	0.015
Occupation‖					
No healthcare provider	62/114 (54.4)	Reference		. . .	. . .
Healthcare provider	35/50 (70.0)	1.957 (0.964–3.974)	0.063	. . .	. . .
Previous CPR training¶					
No	10/28 (40.0)	Reference		Reference	
Yes	33/50 (66.0)	3.494 (1.325–9.213)	0.011	3.432 (1.170–10.071)	0.025

CPR indicates cardiopulmonary resuscitation; EMS, emergency medical service; IQR, interquartile range; OR, odds ratio.
*Data of 6 patients were missing.
†Data of 5 patients were missing.
‡Data of 75 bystanders were missing or unknown.
§Data of 14 bystanders were missing.
‖Data of 56 bystanders were missing or unknown.
¶Data of 142 bystanders were missing or unknown.

result. Second, different from other public health initiatives, such as HIV/AIDS behavior change interventions,[36,37] in which Rogers' innovation-diffusion model[25] was used, 16% of the population might be less than that needed to change the attitude of the population toward CPR and AED use. Third, we trained 23% of the local residence as a total number, but the number of repeaters was unknown. Especially, schoolchildren may have received repeated training over multiple years. And the number of past trainees who moved out from the city was unknown, and whether the net trained residents reached 16%

Table 4. Temporal Trend in 1-Month Survival and 1-Month Survival With Favorable Neurological Outcome

Variable	2010 (n=60)	2011 (n=154)	2012 (n=158)	2013 (n=107)	2014 (n=55)	2015 (n=188)
1-mo Survival	5 (8.3)	8 (5.2)	15 (9.5)	11 (10.3)	4 (7.3)	11 (5.9)
Bystander CPR	3/26 (11.5)	3/64 (4.7)	5/70 (7.1)	4/49 (8.2)	4/23 (17.4)	4/79 (5.1)
No bystander CPR	2/34 (5.9)	5/90 (5.6)	10/88 (11.4)	7/58 (12.1)	0/32	7/109 (6.4)
1-mo Survival with favorable neurological outcome	3 (5.0)	3 (1.9)	8 (5.1)	7 (6.5)	1 (1.8)	6 (3.2)
Bystander CPR	2/26 (7.7)	1/64 (1.6)	2/70 (2.9)	4/49 (8.2)	1/23 (4.3)	1/79 (1.3)
No bystander CPR	1/34 (2.9)	2/90 (2.2)	6/88 (6.8)	3/58 (5.2)	0/32	5/109 (4.6)

Data are given as number (percentage) or number/total (percentage). CPR indicates cardiopulmonary resuscitation.

of the population was uncertain. Fourth, not only CPR training but also a multifaceted and community-wide program using media, advertisement materials, and community presentations might be needed, as previous studies performed.[22–24] Fifth, the threshold to change the attitude of population for CPR and AED use might differ by baseline knowledge, proportion of bystander CPR, nationality, education, regional safety, socioeconomic status, and many other characteristics of each community. Continuous observations to see the association between the dissemination of CPR training and proportion of bystander CPR that occurs in communities are needed to evaluate appropriate strategies to increase CPR and AED use by bystanders.

This study exhibited difficulties to increasing bystander CPR on the scene despite the community attempting to aggressively disseminate CPR training. Widespread CPR training could improve the public awareness toward CPR and contribute increasing bystander CPR in the future, as previous reports indicated.[38,39] Given 82% of events happen at home, then it might be more efficient to educate family members living together with elderly individuals. To increase bystander CPR in the community, both widespread layperson CPR training and targeted training in high-risk populations should be considered. In addition to continuous efforts to provide CPR training in the community, different approaches, such as social media technologies to notify individuals of a suspected neighborhood OHCA event, should be considered. Some studies successfully demonstrated that mobile telephone positioning systems that alerted potential lay responders near suspected OHCA episodes could increase the bystander CPR and AED use.[40,41] These novel technologies can engage individuals, including off-duty medical professionals and past CPR course attendees who are willing and able to provide high-quality CPR and AED use in response to OHCA episodes.

Limitations

An important limitation of this study is that this was a simple before-after observation and we could not evaluate the causal relationship between the wider dissemination of CPR training and an increase in high-quality CPR. The second important limitation was missing data on CPR quality among one third of those who received bystander CPR as well as information on bystanders, including age, sex, occupation, and CPR training experience. However, it is usually difficult to collect this information in emergency settings. Third, the bystander CPR quality was subjectively obtained by EMS personnel and might be biased. We tried to standardize EMS personnel's evaluation on bystander CPR quality by conducting prepractice training and tests and confirming their intraobserver and interobserver reproducibility. Fourth, insufficiency of detailed information about CPR training type is also a limitation. Nevertheless, we believe this study still provides important suggestions about bystander CPR and AED use.

Conclusions

We trained 23% of the residents of a medium-sized city, Osaka, Japan, over a 5-year study period, as planned by using a shortened CCCPR and AED training program. Although high-quality CPR increased gradually, the proportion of bystander CPR and survival remained stable. In addition to aggressive CPR training, multiple approaches would be needed to increase bystander CPR and AED use in the communities.

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Disclosures

Iwami is one of the developers of Mr. PUSH and an executive director of the nonprofit organization Osaka Life Support Association but has no financial conflicts of interest to be declared. The remaining authors have no disclosures to report.

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